

# Costs

Costs to construct a 1 MGD, 2 MGD, 5 MGD, and 10 MGD plant employing filtration and RO such as was demonstrated were estimated. The estimates are based on a 75% recovery rate and using the reclaimed water for irrigation. Because the TDS of the permeate exiting the RO system was less than 200 mg/L, the permeate could be blended with filtered raw water (bypass) to increase the final TDS concentration to 750 mg/L for irrigation supply (14% filtered but undesalted water/86% permeate or a ratio of 6.2:1 permeate to undesalted water).

**Table 5** shows the feed and product water qualities.

**Table 5. Feed and Product Water Qualities**

<b>Constituent</b>	<b>Bypass (mg/L)</b>	<b>Permeate (mg/L)</b>	<b>Blended Product (mg/L)</b>
Calcium	344	6	60
Magnesium	62	1	11
Sodium	950	49	193
Barium	0.45	0.01	0.09
Strontium	2.96	0.05	0.5
Iron	2.34	0.04	0.4
Bicarbonate	264	18	57
Chloride	1455	68	290
Sulfate	873	14	151
Silica	28	1	5
pH	7.20	5.71	6.26
TDS	3,848	154	752

Estimates of capital and operating and maintenance costs for various production rates are presented in the following tables. Costs per acre of land drained are included in the cost tables. These costs were developed assuming that each acre of farmland produces 0.5 AF of drain water per year. The number of acres that could be served by each plant size is obtained by multiplying the feed AFY by two and assuming a Plant Usage Factor (PUF) of 95%. Plant Usage Factor is the hours per year that a plant is operated divided by the total number of hours in a year (8760 hours).

#### **Capital Cost Basis**

RO System - \$1.00/gpd product

Electrical Cost – 10% of the total Equipment Cost

Building Cost - \$70/sqft

Storage Tanks - \$0.50/gallon capacity

Engineering & Contingencies – 60%

Conceptual layout designs are shown in **Appendix F**.

#### **Operating and Maintenance Cost Basis**

Membrane replacement cost was calculated using a membrane life of 5 years.

Electrical power cost was assumed to be \$0.13/KWHr. The majority of the power cost is comprised of pumping power for the RO system, with 25% added for miscellaneous loads. Feed pressure is assumed to be 220 psig, as was seen in the demonstration plant.

Chemical costs are based upon consumption seen in the demonstration plant.

Maintenance cost is estimated to be 2 percent of the plant construction cost excluding engineering, administration, and contingencies.

### **Cost Per Acre Served**

Since a desalination plant treating agricultural drainage water must support itself both by producing saleable water and by increasing crop yields, it is important to know both the cost of water produced, and the cost per acre of land out of production. These costs are provided in **Tables 6 and 7**.

**Table 6** presents the capital cost both as a Grand Total and as a Capital Cost per Acre for each plant size and use. The cost per acre is calculated by dividing the total capital cost by the number of acres served by the plant. The number of acres served depends upon the feed flow to the plant and the amount of drainage water from each acre, which was assumed to be 0.5 acre-feet per year per acre. The feed flow varies for each plant size and use, depending upon the blending rate and the recovery in the RO system. Due to economies of scale, the capital cost per acre reduces from a little over \$1,000 per acre to about \$875/acre as plant size increases from 1 to 10 MGD.

**Table 7** presents the O&M cost both on a total annual cost basis and on an annual per-acre basis. The per-acre O&M cost is calculated by dividing the total annual O&M cost by the acres served, as provided in **Table 6**. As with capital costs, O&M costs show the economies of scale as costs decrease from about \$177/acre to \$126/acre as plant size increases from 1 to 10 MGD.

The costs presented in **Tables 6 and 7** do not take into account the cost of gathering or delivering the water, sale of produced water or offset water rights, or concentrate disposal.

**Water Cost Table 8** gives the cost of water in \$/AF assuming:

- Capital costs (**Table 6**) are amortized over 30 years at 8% interest;
- O&M costs are as shown in **Table 7**; and,
- Annual plant product water production (blend of permeate and undesalted water) is as shown in the table.

As shown in **Table 8**, the cost of water is estimated to range from \$459/AF (10 MGD plant) to \$651/AF (1 MGD). It should be noted, however, that these costs do not include the cost of collecting and transporting the saline water to the desalter or the costs of disposing of

the concentrate. However, the volume of saline drainage water would be reduced by 75%--that portion of the drainage water recovered as usable irrigation water. RO desalination costs would be reduced by the market value of the recovered usable water.

**Table 6. Capital Costs for 1, 2, 5, and 10 MGD Plant**

		<b>1 MGD</b>	<b>2 MGD</b>	<b>5 MGD</b>	<b>10 MGD</b>
		Irrigation			
Feed (gpm)		893	1788	4469	8940
Bypass (gpm)		96	193	481	964
RO Feed (gpm)		806	1579	3935	7882
Recovery		75%	75%	75%	75%
Product (gpm)		<b>694</b>	<b>1389</b>	<b>3472</b>	<b>6946</b>
Acres Served		2,438	4,882	12,201	24,410
RO Process Equipment & Installation		\$1,000,000	\$2,000,000	\$5,000,000	\$10,000,000
Filtration System		\$90,000	\$100,000	\$150,000	\$300,000
Electrical		\$200,000	\$300,000	\$640,000	\$1,300,000
Plant Control System		\$200,000	\$250,000	\$290,000	\$500,000
Chemical Systems		\$150,000	\$200,000	\$200,000	\$600,000
Building Cost		\$175,000	\$230,000	\$300,000	\$600,000
Site Civil		\$10,000	\$20,000	\$20,000	\$30,000
<b>SUBTOTAL</b>		<b>\$1,825,000</b>	<b>\$3,100,000</b>	<b>\$6,600,000</b>	<b>\$13,330,000</b>
Engineering & Administrative Fees	60%	\$1,100,000	\$1,900,000	\$4,000,000	\$8,000,000
<b>GRAND TOTAL*</b>		<b>\$2,925,000</b>	<b>\$5,000,000</b>	<b>\$10,600,000</b>	<b>\$21,330,000</b>
Capital Cost per Acre (\$/acre)**		\$1,200	\$1,024	\$869	\$874

\*Does not include concentrate disposal or cost to get product water to river.

\*\*Based on 0.5 Ac ft per Acre of drain water.

**Table 7. Annual O&M Costs for 1, 2, 5, and 10 MGD Plant**

	<b>1 MGD</b>	<b>2 MGD</b>	<b>5 MGD</b>	<b>10 MGD</b>
	<b>Irrigation</b>			
Membrane Replacement Costs/Yr	\$22,000	\$41,000	\$99,000	\$200,000
Elec. Cost/Yr	\$170,000	\$330,000	\$830,000	\$1,700,000
Labor/Yr	\$150,000	\$150,000	\$300,000	\$450,000
CIP Chem Cost/Yr	\$6,000	\$12,000	\$12,000	\$24,000
Chemical Cost/Yr	\$28,000	\$55,000	\$140,000	\$280,000
Maintenance Cost/Yr	\$56,000	\$66,000	\$210,000	\$414,000
<b>Total (\$/Yr)</b>	<b>\$432,000</b>	<b>\$654,000</b>	<b>\$1,591,000</b>	<b>\$3,068,000</b>
<b>\$/Ac-Ft</b>	<b>\$400</b>	<b>\$302</b>	<b>\$294</b>	<b>\$284</b>
<b>\$/Kgal</b>	<b>\$1.18</b>	<b>\$0.90</b>	<b>\$0.87</b>	<b>\$0.84</b>
<b>\$/acre</b>	<b>\$177</b>	<b>\$134</b>	<b>\$130</b>	<b>\$126</b>

**Table 8. Water Costs**

	<b>1 MGD</b>	<b>2 MGD</b>	<b>5 MGD</b>	<b>10 MGD</b>
	<b>Irrigation</b>			
RO Permeate (AFY)	964	1,930	4,825	9,649
Bypass (AFY)	116	233	582	1,166
Product Water (AFY)	1,080	2,163	5,406	10,815
Capital Cost	\$2,925,000	\$5,000,000	\$10,600,000	\$21,330,000
Annual Capital (\$/Yr)	\$260,000	\$445,000	\$942,000	\$1,900,000
Annual O&M (\$/Yr)	\$432,000	\$654,000	\$1,591,000	\$3,068,000
Total Annual Cost (\$/Yr)	\$692,000	\$1,099,000	\$2,533,000	\$4,968,000
Water Cost (\$/AFY Production)	\$641	\$508	\$469	\$459